Building Research Establishment Digest

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Cavity barriers and ventilation in flat and low-pitched roofs

Cavity barriers restrict the spread of smoke and flame; they are required by Building Regulations in certain types and sizes of new building and have been installed in some existing buildings. In flat and low-pitched roofs with a continuous weather-proof layer problems do not normally arise if cavity barriers are used in warm roof deck designs, but in cold roof deck designs care must be taken to ensure that there is adequate ventilation of the roof cavities. A total clear opening area of not less than 0.3 per cent of the plan area of the cavity should be used.

The practical problems of choosing appropriate materials and methods of fabrication and erection of cavity barriers and fire stops are discussed in Digests 214 and 215. This digest assesses the implications for ventilation of using cavity barriers and examines, where necessary, how adequate air movement can be provided in both new and existing flat roof voids, designed with or having installed cavity barriers.

This digest does not purport to be an authoritative interpretation of the legal requirements of the Building Regulations but has been produced as an aid to understanding their technical intention.

Voids often occur in flat and low pitched roof construction, particularly those with suspended or separate ceilings. Their presence has many advantages such as providing a space to contain pipework and other services. Ceilings can be constructed to resist the passage of fire but inadequacy of design and construction, the presence of openings or failure in fire are liable to allow smoke and hot gas to enter the void and spread rapidly through the horizontal plane. Following a number of fire incidents and fatalities particularly in institutional types of building, the Building Regulations, 1976, introduced requirements for the provision of cavity barriers and for fire stopping to restrict the unseen spread of fire and smoke.

The requirements to restrict the spread of smoke and flame, however, do not negate the need for providing ventilation in the cavities of certain forms of roof construction and particularly those with a continuous waterproof layer. The installation of cavity barriers and fire stopping without appreciating the implications for ventilation could seriously impair the efficiency of air movement. This could lead to a build up of moisture within the roof construction which can cause deterioration of many building materials resulting in the possibility of structural collapse.

Cavity barriers

A cavity barrier is defined in the 1976 Building Regulations (Part E, Safety in Fire, Regulation E14) as a construction to restrict movement of smoke or flame within a cavity, including a construction provided for another purpose if it conforms with the criteria required of a cavity barrier. The requirement for the installation of cavity barriers and the maximum permitted distance between cavity barriers are related to the Purpose Group of the building and are set out in the table to Regulation E14(4), the relevant part of which is given below.

Table 1 Maximum distance between cavity barriers in a roof void.
Based on the table to Regulation E14(4) of the Building Regulations 1976 and irrespective of the class of exposed surface within the cavity (excluding pipes, cables or conduit).

Purpose group of building or compartment	Maximum distance
I and flats or maisonettes within III	No limit (Cavity barriers not required)
II and III except flats and maisonettes	15 m with area limited to 100 m²
Any other	20 m

Purpose group I covers private dwelling houses, PG II institutional and PG III other residential buildings. Purpose groups IV, V and VI cover offices, shops and factories, respectively, VII embraces other places of assembly and finally, VIII is for storage and other general buildings.

It should be noted that cavity barriers are not required by E14(4) to subdivide roof voids in purpose group I buildings or for flats and maisonettes in purpose group III, although some barriers in and at the perimeter of voids may nonetheless be required by E14(2) and (3). In all other purpose groups, cavity barriers may be required in roof voids by E14(4) as well as by E14(2) and (3).

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Digests 214 and 215 examine in detail appropriate materials and methods of fabricating suitable cavity barriers. Building Regulations and the Digests seek to achieve, in the materials and constructions they describe, a close fit of the barrier in the cavity and at the joint between the barrier and any through-going services. Thus the passage of air is restricted and any requirements for ventilation must be met within the permitted maximum distances and areas that result from the sub-division of roof space by the cavity barriers.

Flat roof design

The detail and construction of flat roofs varies greatly but currently it is common practice to classify them according to the location of the insulation in relation to the deck as being of warm or of cold roof deck design, see Digest 180.

Warm roof deck

In warm roof deck design the insulation is placed immediately below the waterproof layer with a vapour barrier beneath the insulation and on the upper side of the roof deck. The ceiling may be independently suspended at a lower level providing a cavity between the ceiling and the roof which is not ventilated with outside air. The roof deck is consequently warm and the insulation is protected from reaching dew point conditions by the vapour barrier on its warm side.

Since any cavity formed between the roof deck and the ceiling does not require ventilating this method of construction is not affected by the installation of cavity barriers. However, a warm roof deck design does not necessarily provide the best design solution for buildings requiring cavity barriers, particularly as other problems must be considered, for example the movement of the thermal insulation and its effect on the integrity of the water-proof layer and the costs incurred in the future for the replacement of the water-proof layer.

Cold roof deck

In cold roof deck design the insulation is placed immediately above the ceiling, usually with a vapour barrier interposed. A cold void is thus created between the insulation and the roof-deck, which supports directly the water-proof layer. Outside air is allowed to pass through this cavity helping to clear any build-up of moisture which could result from the percolation of interior air from beneath the ceiling (see Fig. 1). In addition, as the waterproof layer and supporting upper deck approach the outside temperature, the ventilation minimises the risk of condensation occurring on the deck. It is possible, however, by the use or installation of cavity barriers to interrupt or impair the efficiency of the ventilation, and it is this form of roof deck design, or variations of it, that are mostly affected by the use of cavity barriers in both new and existing buildings.

Existing roof decks

In view of recent experiences and legislation it may be considered necessary to install cavity barriers in certain existing buildings. In such cases the roof structure should be carefully examined and classified either as warm or as cold roof deck design. If warm, no problems should arise; if cold, then the implications for ventilation must be considered. If for some reason cavity barriers have already been installed in an existing cold roof without considering the implications for ventilation then the roof structure should be examined immediately and the necessary provision made for ventilation.

It is clearly possible to provide the ventilation needed between cavity barriers by roof cowl ventilators. However, it would be an advantage to have the additional facility of being able to use eaves or perimeter ventilation. At present it is necessary to obtain a relaxation of Regulation E14(2)(a) for this purpose; however, there are proposals to amend the regulation in order to permit generally in external walls the use of eaves ventilation openings to the adjacent sub-divided roof cavities. An additional advantage of providing roof ventilation is to assist with the clearance of smoke which may enter the void. However, the size of ventilation openings normally provided may be inadequate for complete smoke clearance.

If an existing building has little thermal insulation then the question of upgrading may occur at the same time as the installation of cavity barriers. Great care must be exercised in this situation. A complex solution combining cold and warm roof deck design should be avoided as should any possible duplication of vapour barriers, as experience has shown that these types of solution are often unsatisfactory.

Methods of ventilation

In most cases ventilation in flat and low-pitched roofs relies on intermittent winds of varying direction and intensity. For the ingress and exhaustion of air it is, therefore, necessary to arrange ventilators at least at both ends of a cavity avoiding the occurrence of any dead pockets of static air. Openings at one end of a cavity will not provide sufficient movement of air. A flow of air may be induced thermally where a deep roof zone is available by providing ingress at the lower eaves and escape at the high point of the roof or ridge. Apertures may be arranged in the form of cowls through the weatherproof layer or, in cases where the local authority agrees to relaxation of E14(2)(a), of openings either on the facade of the building within the roof zone, or at the underside of any roof overhang. In some forms of construction it is possible to provide ventilation at the base of a flush fascia detail, but care must be taken not to infringe the integrity of any required cavity barrier or to impede the flow of air by other construction materials such as insulation or rendering (Fig 1). In order to provide adequate ventilation within the voids between cavity barriers, it may be necessary to combine alternative types of aperture, particularly with large complex roof areas (Fig. 2).

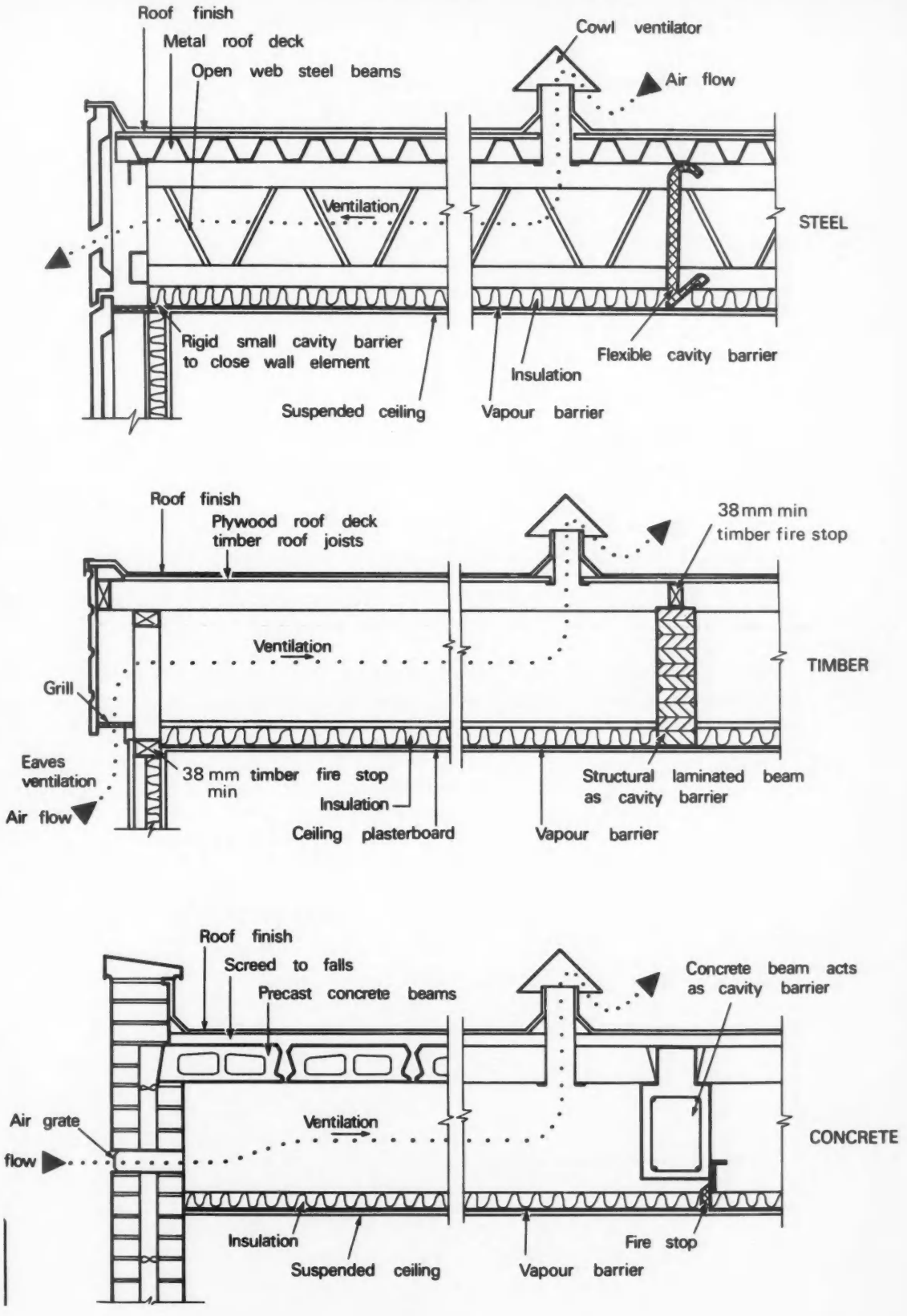

Fig. 1 Typical cold roof deck construction showing ventilation detail

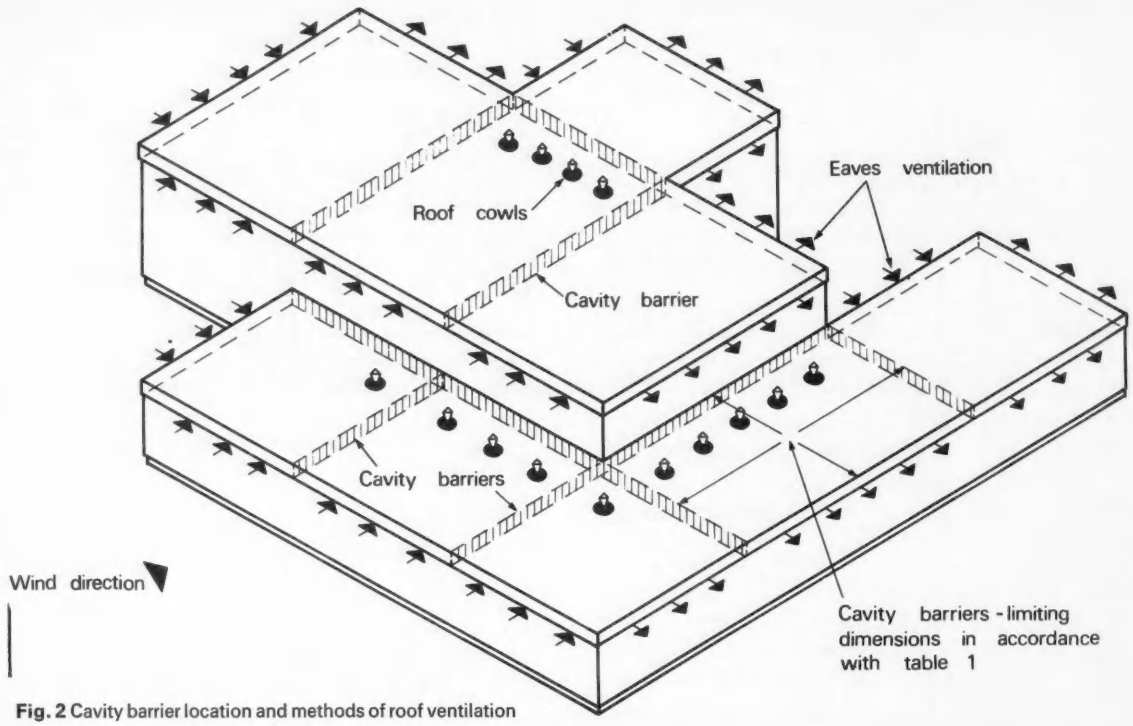

Fig. 2 Cavity barrier location and methods of roof ventilation

The amount of clear aperture area required to give adequate ventilation will vary according to location, and the efficiency of the air movement. Since, however, material degradation does not occur, and performance of cold roof construction is not affected by an excess of ventilation it would seem appropriate to use a minimum distributed clear aperture opening area of not less than 0.3 per cent of the total plan area of the cavity, increasing this figure extensively wherever possible and especially when achieving satisfactory distribution within the cavity becomes difficult because of plan configuration. Thus a roof with a span of 30 m and with a cavity barrier at mid-span will require an aperture area of 0.023 m^2 for each metre of width and at each end of the two cavities formed. This could be met by a continuous 23 mm wide slot or by air grates or ventilators each having a clear aperture of 0.023 m^2 and spaced at 1 metre intervals.

Unusually-high relative humidities may occur in certain buildings such as those associated with swimming pools, service kitchens and some industrial processes. In these cases special arrangements should be made to exhaust the wet air from the building using fans and in the case of cold roof deck design a similar approach should be taken with the roof voids. Attention also needs to be paid to the selection and location of the materials used in the roof construction to ensure that any damp conditions that may arise do not cause deterioration.

Ventilator design

Many types of ventilators, including louvres and cowls, both directional and non-directional are available and some are designed to ventilate the cavities in cold roof deck design. In some cases the ventilation can be incorporated as part of the construction detail. Where ventilators penetrate the waterproof layer care must be taken in detailing to ensure that there is no possibility of water ingress *around* the ventilating device into the roof space. Ventilators should be selected and sited to achieve the following:

induce maximum air flow throughout the full length of a cavity without infringing cavity barrier requirements;

be of sufficient clear opening area to provide the required ventilation rate;

prevent the ingress of snow, rain, insects, birds and leaves;

be sited to facilitate inspection;

be located so that there is no danger of obstruction in the void by loose materials, such as insulation;

be of maintenance-free materials and constructed to avoid the occurrence of condensation within the ventilator.

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